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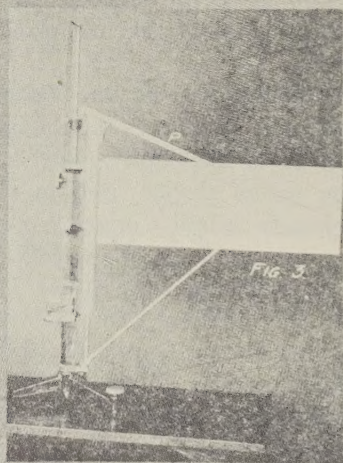
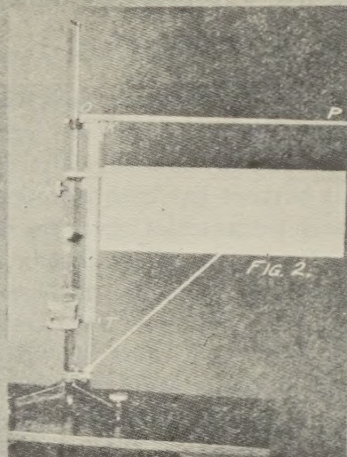
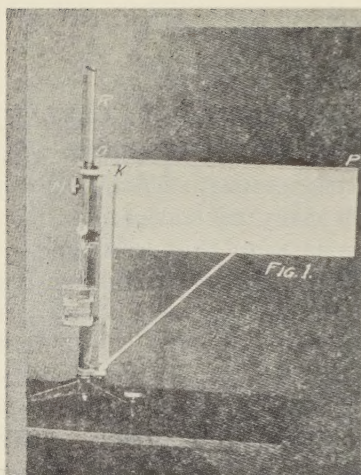
A CALCULATING JOLLY BALANCE

EDWARD H. KRAUS, *University of Michigan.*

In 1911 a recording Jolly balance was described¹ by which the determination of specific gravity was greatly simplified, only two readings and a single division being necessary. Since that time this balance has been introduced in many mineralogical and research laboratories where the determination of the specific gravity of minerals or solids must be frequently made. Of the research laboratories using one of these balances mention must be made of that of the Champion Porcelain Company of Detroit. In that laboratory it became necessary several years ago to make very rapid determinations of the specific gravity of some of the minerals used in the manufacture of spark plug porcelain. In order to reduce the time necessary for such determinations the balance was further perfected by a member of the research staff who devised a calculating attachment. It soon became known to me that such an attachment had been worked out but up to the present time I have not seen it. Furthermore a description of that calculating attachment has never been published.

In the fall of 1925 I devoted considerable time to the further development of the balance, as described in 1911, with the thought of devising a calculating attachment. After this improvement had been worked out, drawings of the earlier device used in the research laboratory of the Champion Porcelain Company were placed at my disposal through the courtesy of Dr. J. A. Jeffery. The principle used in both of these attachments is the same. The balance to be described marks a decided advance over the 1911 model and is a mechanical improvement over the one perfected in the laboratories of the Champion Porcelain Company, for it is not only a calculating instrument but may also be used for the actual naming of the mineral under consideration.

¹Kraus, Edward H., A NEW JOLLY BALANCE, *Am. J. Sc.*, (1911) XXXI, 561-563; also EINE NEUE JOLLY'SCHE FEDERWAGE ZUR BESTIMMUNG DES SPECIFISCHEN GEWICHTS, *Centr. Min., etc.*, (1911), 11, 366-368.



In describing the new balance use will be made of three photographs and two drawings. The new attachments consist (Fig. 1) of a horizontal graduated scale and a chart of mineral names both rigidly attached to the right side of the balance proper and supported by an inclined rod. Directly above the horizontal scale there is a movable pointer *P*, which pivoting at *O* rests on a knife-edge *K* (Figs. 1 and 2).

The balance is used, as described in the earlier papers, by bringing the horizontal sighting disk opposite the horizontal mark on the mirror directly back of the disk. This can be done approximately by adjusting the length of the rod *R*, and then accurately by the fine adjustment screw *F*. Figure 1 shows the balance after this adjustment has been made. The specimen to be determined is then placed in the upper scale pan. The sighting disk is again brought opposite the mark on the mirror, this time by turning the milled head *M* so as to drive the vertical support of the spiral spring upward and thus elongate the spring. Figure 2 shows that in this operation the movable pointer *P* also moves upward, the horizontal graduated scale and the chart remaining as in Figure 1.

When the sighting disk is again exactly opposite the mark on the mirror the screw *T* is tightened. The specimen is now transferred to the scale pan in water and the milled head *M* turned so as to shorten the spring until the sighting disk is for the third time opposite the mark on the mirror. In doing this the knife-edge *K* moves downward. This permits the pointer *P*, pivoting at *O*, to fall and assume an inclined position across the horizontal graduated scale (Fig. 3). The inclination of the pointer obviously depends upon the relative positions of the pivot *O* and the knife-edge *K*. The reading on the graduated scale where the pointer intersects its upper edge is the specific gravity of the specimen. The name or names of the minerals on the chart directly below this point indicate the probable identity of the mineral under consideration. Only common minerals have been listed on the chart shown in the accompanying cuts.

The mineral used for this demonstration was a specimen of crystallized chalcocite from Cornwall, England. The enlarged portion of the horizontal graduated scale showing the intersection with the pointer (Fig. 4) plainly indicates the specific gravity as being 5.61 and that the specimen should be chalcocite.

The mechanical calculation obviously depends upon the use of the similar triangles CAE and CBD , as shown in Fig. 5, where CA is proportional to the weight of the specimen in air (W) and CB to the loss of weight of the specimen in water (L). The unit used in the horizontal graduated scale is BD , the horizontal distance between the center of the pivot O and the knife-edge K . The following relationships between these sides of the two triangles now becomes obvious.

$$\frac{W(\text{weight in air})}{L(\text{loss in water})} = \frac{AE}{BD} = Sp. Gr.$$

$$BD = 1$$

$$\text{Therefore } Sp. Gr. = AE$$

The graduated scale used with the balance, as shown in the figures, permits of the determination of solids with specific gravities up to 12. For heavier substances the pointer P may be moved to the right so that the distance between the pivoting point O and the knife-edge K (BD in Fig. 5) is reduced one-half. A properly placed hole is provided for this purpose. When O is in this half-way position the readings on the graduate scale must obviously be doubled, and it now becomes possible to determine values up to 24.

Where rapid determinations of the specific gravity of solids is a matter of routine, or where the time element is of great importance, this new instrument has many advantages over the older forms of jolly balances.

The attachments described in this paper were made by Mr. Ralph Miller of the Eberbach and Son Company of Ann Arbor, Michigan, to whom I wish to express my appreciation for his very expert assistance.

HYALOPHANE FROM FRANKLIN FURNACE, NEW JERSEY

L. H. BAUER, *Franklin, N. J.*, AND C. PALACHE, *Harvard University*

This barium feldspar was discovered at Franklin Furnace by the chemists of the New Jersey Zinc Company. A mass of coarse granular feldspar, dark red in color, was found in the old dump of the Parker Shaft and upon analysis showed the presence of more than 10 per cent of barium oxide. It is associated with the black

manganese biotite and yellow garnet so common in that locality. In thin section the feldspar was found to be monoclinic with small extinction angle, negative, 2 V large, and a refractive index β about 1.54. Specific gravity 2.90. Hardness 6. It is very impure, the dark color being due to the presence of grains of hancockite and to a network of microscopic veinlets of what was apparently bementite, evidently an alteration product. The analysis, made by Jenkins & Bauer, follows:

SiO ₂	45.40	FeO	1.54
Al ₂ O ₃	20.82	MnO	2.67
K ₂ O	7.54	ZnO	1.36
Na ₂ O	2.69	PbO	1.15
BaO	10.58	SO ₃	0.99
CaO	2.70	H ₂ O	2.35
MgO	0.76	Total	100.55

This analysis was discussed on the basis of the observed impurities in the following manner. The SO₃ was regarded as contained in barite. The PbO was assigned to hancockite and the remainder of the bivalent oxides, except BaO, was assigned to bementite. It is evident that such a calculation must be very approximate since neither hancockite nor bementite has a constant composition. The result of the calculation was as follows:

Barite	2.89 Per cent
Hancockite	5.48
Bementite	15.71
Excess H ₂ O	1.00
	<hr/>
	25.08

Recalculating the remainder of the analysis to 100% the following figures were obtained:

	PER CENT	MOLECULAR RATIOS	
SiO ₂	49.51	.821	.821 = 4 × .205
Al ₂ O ₃	25.48	.249	.249 = 1 × .249
K ₂ O	9.98	.106	} .238 = 1 × .238
Na ₂ O	3.56	.057	
BaO	11.47	.075	
	<hr/>		
	100.00		

This result approximates the composition of a soda-bearing hyalophane but is slightly deficient in silica. The optical characters

are thus supported by the analysis. An attempt was made to purify some of the finely ground feldspar in heavy solution but it proved to be impossible, the finest particles of powder still showing a network of the alteration products. The calculated amount of the impurity, 25%, did not seem unduly large in view of the abundance of the secondary bementite.

It is interesting to note that this occurrence adds one more mineral to the list of those common to Franklin Furnace and the manganese mines of Långban and Jakobsberg, Sweden. The hyalophane of the latter place is also a granular red feldspar associated with manganese epidote.

MARCASITE INCLUSIONS IN FLUORITE FROM THE CENTRAL KENTUCKY BARITE-FLUORITE- CALCITE VEINS

WILLIAM DRUMM JOHNSTON, JR., *University of Cincinnati*

INTRODUCTION

The occurrence of marcasite as inclusions in fluorite from the barite-fluorite-calcite veins of Central Kentucky is of genetic significance. These veins have been described by Miller¹, Fohs², and recently by Currier.³ In the main, the veins have a north-south trend paralleling the axis of the Cincinnati anticline, altho departure from this general strike is not uncommon. The country rock is Ordovician limestone from the Camp Nelson formation, exposed on the crest of the Cincinnati anticline, to the top of the Trenton. There are several conspicuous fault zones in the central Kentucky region, and vein material is associated with all of them, usually however, occurring in tension fissures without vertical displacement as vein filling from a few inches to seven feet in width. Barite, fluorite, and calcite are the principal vein minerals, with minor amounts of galena and sphalerite, and oc-

¹Miller, A. M.; The Lead and Zinc Bearing Rocks of Central Kentucky, Ky. *Geol. Survey, Bull.* 2, (1905). *Geology of Kentucky. Ky. Geol. Survey, Series V, Bull.* 2, (1919).

²Fohs, F. Julius; Fluorspar Deposits of Kentucky, Ky. *Geol. Surv., Bull.* 9, (1907); Barytes Deposits of Kentucky, Ky. *Geol. Surv., Series IV, Vol. 1, Part I*, (1913).

³Currier, Louis Wade; Fluorspar Deposits of Kentucky, Ky. *Geol. Survey, Series VI. Vol. 13*, (1923).

asionally smithsonite and celestite. The deposits are often banded. Great variation in mineral composition occurs along the strike of the veins. The limestone of the country rock is not replaced, consequently the vein walls are sharp.

PURPOSE OF THE PRESENT PAPER

It has been customary to interpret the origin of the central Kentucky veins by analogy with the fluorite veins of western Kentucky and southern Illinois, as they have a similar mineralogic composition. It is natural that this analogy should extend so far as to lead to the general conclusion that the central Kentucky barite-fluorite-calcite veins are genetically identical with the fluorite-calcite-galena-sphalerite-quartz veins of western Kentucky and southern Illinois. Field evidence, however, does not justify an interpretation of hypogene⁴ origin for these deposits. Rather, the absence of wall rock replacement, of associated dikes, and of quartz, and the occurring type of tension fissures in which the vein material is deposited point toward a parent solution of low acidity and low temperature. The occurrence of marcasite inclusions in fluorite will be noted as being in agreement with the field evidence for such conditions.

THE OCCURENCE OF MARCASITE

The accompanying sketch map (Fig. 1) shows the outcrop of a group of related veins exposed in the bluff of the Kentucky River. While the four mines are situated in a straight line, the continuity of the veins has not been established. In the Chinn mine, the minerals are calcite with occasional sphalerite, barite, and fluorite, while in the others barite and fluorite dominate, with some calcite and occasionally a small amount of galena and sphalerite.

Fluorite with marcasite inclusions was collected by the writer from the Fairchild and Twin Chimney mines. In all, some fifty specimens of fluorite containing marcasite rods were obtained. Those from the Fairchild mine were collected from the vein face, and those from the Twin Chimney mine were from both the mine and the mineral storage bin.

⁴Ransome's definition to denote *hot* ascending solutions is intended, see Ransome, F. L.; *Prof. Paper* 66, U. S. Geological Survey, pp. 169-170, (1909)

The marcasite is here, for convenience, described as (1) random inclusions in which the position of the rods bears no relation to crystallographic structure of the fluorite and (2) oriented inclusions in which the marcasite rods are arranged in definite relation to crystallographic faces (which may or may not be developed) in the fluorite.

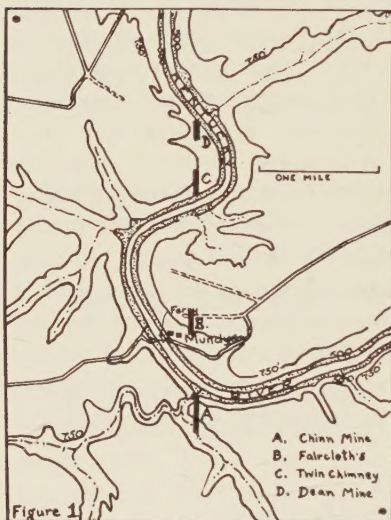


FIG. 1

Sketch map of the veins near Munday's Landing, Kentucky. The country rock is Ordovician limestone.



FIG. 2

Fluorite from the Twin Chimney mine, Mercer County, Kentucky. The marcasite is oriented normal to all cube faces.

RANDOM MARCASITE

Fig. 3, B—is a fragment of fluorite with random marcasite rods from the Fairchild mine, Woodford County, Kentucky. It is typical of the greater number of specimens collected from both mines. The marcasite rods are not arranged in any definite crystallographic direction. The occurrence is significant only in as much as the marcasite is indicative of certain physical-chemical conditions existing at the time of its formation, i.e., the formation of the fluorite and of the veins.

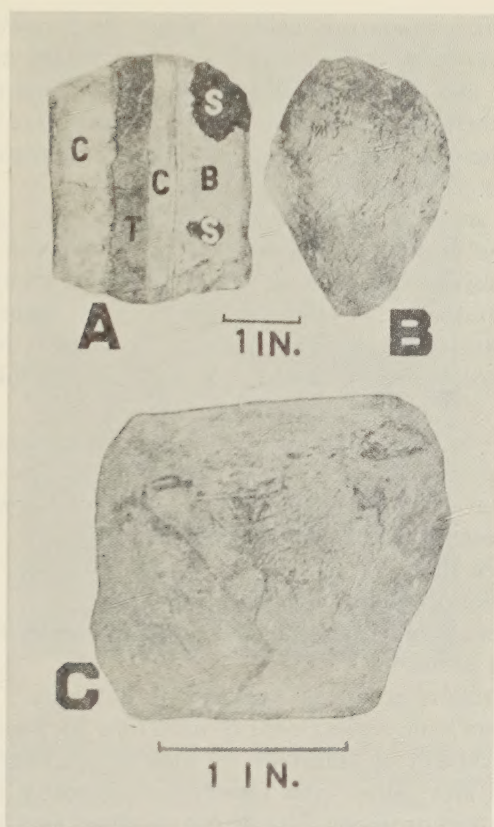


FIG. 3

A—Fragment from Calcite-barite-fluorite vein at Faircloth Mine, Woodford County, Kentucky. T, Tyrone Limestone; B, barite; C, Calcite; S, sphalerite. Fluorite occurs as selvage on the left between the limestone and the calcite, and in the barite.

B—Fluorite from Faircloth Mine with random inclusions of marcasite.

C—Fluorite from Twin Chimney Mine, Mercer County, Kentucky, with oriented inclusions of marcasite. The marcasite rods are arranged approximately perpendicular to the forms (011), (110), and (101).

PARAGENESIS. The work of Allen and Crenshaw⁵ upon the formation of marcasite and pyrite is well known. They found that

⁵Allen, E. T., Crenshaw, S. L., and Johnston, John; The Mineral Sulfides of Iron, *Am. Jour. Sci.*, (4), **33**, pp. 169-236, (1912).

at a constant temperature, acidity favors the formation of marcasite, and non-acidity favors pyrite. At constant acidity, high temperature favors pyrite, and low temperature marcasite. The conditions, then, under which marcasite is formed are low temperatures and acidity; and conversely, high temperatures and non-acidity favor the formation of pyrite.

A recent scrutiny of the geological occurrence of marcasite by Newhouse⁶ found no disagreement with their work.

As previously stated, there is little evidence for applying Bain's⁷ magmatic interpretation of the Illinois fluorspar veins to those of central Kentucky. Additional negative evidence is furnished by the occurrence of the iron sulfides as inclusions in fluorite in the two regions.

Fig. 4, A—is a photograph of a cleavage fragment of fluorite containing pyrite inclusions from the Hillside Fluorspar mine, Hardin County, Illinois. Two points will serve to contrast the iron sulfide occurrences in the two regions.

In southern Illinois

- (1) Pyrite occurs as inclusions in fluorite.
- (2) There is much replacement of limestone by fluorite.

In central Kentucky

- (1) Marcasite occurs as inclusions in fluorspar.
- (2) There is no replacement of limestone by fluorite.

The replacement of limestone by fluorite can take place only in acid solutions; either the limestone is directly replaced by hydrofluoric acid or silicon fluoride is hydrolized and then replacement by hydrofluoric acid takes place. But as pyrite, which was not favored by acidity, is found, the controlling factor in the formation of southern Illinois fluorite was temperature.

In the Kentucky veins marcasite is found as inclusions in fluorite, and there is no appreciable replacement of the country rock by fluorite. This is indicative of the absence of hydrofluoric acid and of silicon fluoride, that is, of acid solutions. But here marcasite, which is favored by acidity, is formed. Hence low temperature was the controlling factor in the formation of the marcasite in the central Kentucky veins. It is obvious, then, that the difference

⁶Newhouse, W. H.; Paragenesis of Marcasite, *Economic Geology*, XX, pp. 54-66 (1925).

⁷Bain, H. F.; The Fluorspar Deposits of Southern Illinois, *U. S. Geol. Survey Bull.* 255, (1905).

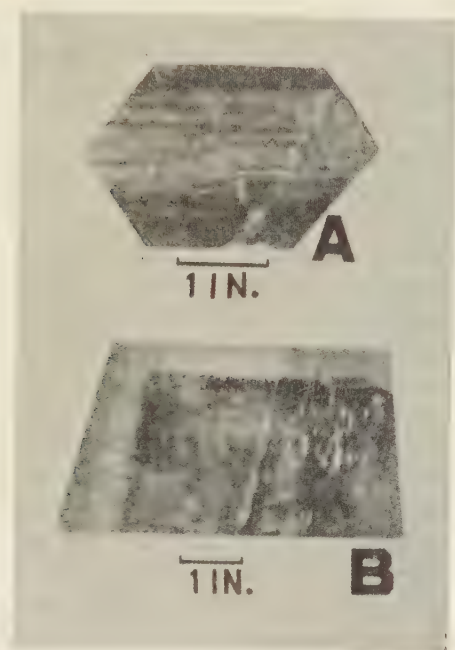


FIG. 4

A—Fluorite from Hillside Fluorspar Mine, Hardin County, Illinois, with inclusions of pyrite. The pyrite occurs in zones, paralleling one pair of cube faces.

B—Calcite from Roach's Crystal Cave, Joplin, Missouri, with oriented inclusions of marcasite. The marcasite rods are arranged perpendicular to crystal faces.

in temperature and the difference in acidity between the veins of central Kentucky and western Kentucky-southern Illinois region is marked and should it be found desirable to consider the central Kentucky veins as vein-dikes, surely they must be placed at considerably greater distance from the magma than those of western Kentucky and southern Illinois.

ORIENTED MARCASITE

CENTRAL KENTUCKY. The Twin Chimney mine furnished all fluorite in which the marcasite rods were arranged with definite crystallographic orientation. Fig. 3, C—shows a cleavage fragment of fluorite in which the marcasite rods are arranged approximately perpendicular to the forms (011), (110), and (101). Specimens of

this arrangement are the most common of the oriented group. Less common is the type shown in Fig. 2. Here the marcasite rods are arranged perpendicularly to all cube faces. The specimen is from a vug.

JOPLIN, MISSOURI. Merwin⁸ has described calcite containing marcasite rods arranged normal to planes representing crystal faces. From the step-like interlocking of the rods at the intersection of two faces of the calcite, he concludes that the marcasite and calcite crystallized together. Fig. 4, *B*—of a specimen belonging to the University of Cincinnati shows a crystal of calcite with marcasite rods from Roach's Crystal Cove, Joplin, Missouri.

Oriented marcasite indicates one other condition at the time of vein filling. Locally, at least, the parent solutions were static.

SOUTHERN ILLINOIS. In Fig. 4, *A*—illustrates a cleavage fragment of fluorite with pyrite inclusions from the Hillside fluorspar mine, Hardin County, Illinois. The pyrite occurs in zones parallel to one pair of cube faces.

Recently, Steinmetz⁹ has described oriented inclusions of chalcopyrite and pyrite in fluorite from Wölsenberg. The inclusions are arranged in a variety of small regular patterns, and are thought to have been deposited from hot solutions as gel on the fluorite. Contraction and dehydration of the gel with the subsequent burial of the sulfides by the growth of the fluorite crystal give rise to the regularly arranged inclusions.

CONCLUSIONS

1. The occurrence of marcasite in the central Kentucky barite-fluorite-calcite veins is indicative of a low temperature of the parent solutions at the time of vein filling.

2. The inclusions of marcasite in fluorite in central Kentucky, and pyrite in fluorite in southern Illinois strongly suggest that the two deposits were deposited under different physical-chemical conditions, those in southern Illinois being more intense than those in central Kentucky.

3. Oriented marcasite inclusions in central Kentucky veins suggest a static parent solution.

⁸Merwin, H. E.; *Am. Jour. Sci.*, 4th ser., **38**, 355-359, (1914).

Steinmetz, H.; *Z. Kryst.*, Festband P. v. Groth, **58**, 330-339, (1923).

THE CHEMICAL CONSTITUTION OF THE
TETRAHEDRITE-TENNANTITE SYSTEMA. N. WINCHELL, *University of Wisconsin*

The application of the theory of atomic isomorphism to the problems of the constitution of the silicates has led to such favorable results that it seems reasonable to test the possibility of applying the same theory to the ore-minerals. The following study of the constitution of the tetrahedrite-tennantite system may be considered as part of this work.

Most of the standard text-books¹ of mineralogy now give the formula of tetrahedrite as $\text{Cu}_3\text{Sb}_2\text{S}_7$ with the comment that Ag, Zn, Fe, etc., may "replace" part of the Cu under valence control. That is, $\text{Ag}_3\text{Sb}_2\text{S}_7$, $\text{Zn}_3\text{Sb}_2\text{S}_7$ and $\text{Fe}_3\text{Sb}_2\text{S}_7$ are supposed to be possible constituents of tetrahedrite crystals to some extent. It is too early as yet to claim that the constitution of tetrahedrite can be expressed in any form which is correct beyond question, but it is at least possible to show conclusively that the current formula is incorrect, if the best analyses now available can be trusted.

Doelter² has recently summarized the literature dealing with the composition of tetrahedrite; he has also given tables of atomic ratios based on many of the analyses collected by Henglein³. Any further discussion may seem untimely, but Doelter makes no attempt to reach any conclusion except that it is impossible at present to give an uncontested formula for tetrahedrite. Therefor it is hoped that something can be gained by a study of the best analyses. Many tetrahedrite analyses are too old to have been made by the best modern methods; some are obviously incomplete, others were made on material not carefully selected; and not a few give unsatisfactory results when the calculated sulphur (to satisfy the bases) is compared with the reported sulphur⁴. It is unfortunately true that practically all analyses

¹Dana: System and Textbook; Brush-Penfield: Determ. Mineral.; Moses and Parsons: Mineral. Cryst. Blowp. Anal.; and Kraus & Hunt: Mineralogy.

²Doelter: Handb. Mineralch. IV pp. 203-218, (1925).

³Doelter: Handb. Mineralch. IV pp. 173-203, (1925).

⁴The sulphur has been calculated according to the ordinary views regarding the valence of the bases and also according to the theory of Wherry and Foshag. No analysis has been rejected on account of unsatisfactory sulphur unless the reported sulphur would not check the sulphur *calculated either way*. However, this double calculation has had very little effect on the selection of analyses; if the sulphur were calculated only the first way analysis 19 would be rejected and analysis 1 would be in doubt.

now available were made on samples whose purity was not tested by microscopic methods; therefore it is all the more important to scrutinize the analyses carefully and eliminate all those which are not satisfactory according to the tests enumerated. By the methods outlined the 33 analyses of Table I were selected from the 136 on record; they are believed to be the best analyses of the tetrahedrite-tennantite system of minerals now available. In Table 1 the selected analyses have been recalculated⁵ into atomic percentage composition.

A brief study of Table I is sufficient to show that the formula $\text{Cu}_8\text{Sb}_2\text{S}_7$ is incorrect. That formula requires for Cu 47.06 per cent, for Sb 11.77, and for S 41.18. As a matter of fact S ranges from 42.27 to 45.3, averaging about 44.5; Sb(+ As + Bi) ranges from 12.56 to 14.4, averaging about 13.6; and Cu(+ Ag + Zn + Fe, etc.) ranges from 39.26 to 44.81, averaging about 41.7.

Wherry and Foshag⁶ have recently proposed a new formula for the tetrahedrite-tennantite system which represents the averages of the analytical data much better than the old one. They believe that Zn and Fe do not proxy for Cu but are always present in definite amount except when there is some divalent Cu. According to them the formula is $\text{Cu}_{10}(\text{Zn}, \text{Fe}, \text{Cu})_2\text{Sb}_4\text{S}_{13}$. This requires 41.4 percent of Cu + Ag + Zn + Fe, divided into 34.4 of monovalent Cu + Ag and 6.6 of divalent Zn + Fe + Cu; it also requires 13.8 percent of Sb + As and 44.8 percent of S. If tetrahedrite has a fixed tenor of S it is probable that this formula is correct, but in a few cases analyses made with the greatest care on excellent material show an important deviation from the average value.

As early as 1899 Prior and Spencer⁷ offered a different explanation of the constitution of tetrahedrite. According to them it consists of $\text{Cu}_6\text{Sb}_2\text{S}_6$ with or without minor amounts of $(\text{Zn}, \text{Fe})_6\text{Sb}_2\text{S}_9$. This explanation may be considered to be inconsistent with the atomic theory of isomorphism, but that theory, at least as understood by the writer, rests fundamentally on the proposition that a crystal atomic space-lattice can vary in constitution in

⁵In the computations necessary to prepare Table I the writer has had the helpful cooperation of R. C. Emmons, Emilie Hahn, R. H. B. Jones, C. H. Stockwell, and T. B. Williams.

⁶*Jour. Wash. Acad. Sci.* XI, p. 1, (1921).

⁷*Mineral. Mag.* XII, 183, (1899).

TABLE I. ATOMIC PERCENTAGE COMPOSITION OF MINERALS OF THE TETRAHEDRITE-TENNANTITE SYSTEM FROM "SUPERIOR" ANALYSES

Analyst.	Date	S	As	Sb	Cu	Ag	Zn	Fe	Others	G	Doelter No.	Page
1 Prior.....	1899	43.8	.....	13.8	41.0	.....	.....	1.35	Pb=0.03	4.921	15	175
2 Prior.....	1899	44.3	.....	13.75	38.1	.....	2.35	1.06	Pb=0.18, Bi=0.23	4.969	16	175
3 Kretschmer.....	1911	44.5	.....	13.8	34.4	.06	5.76	1.14	Pb=0.2, Bi=0.14	5.079	17	175
4 Pilipenko.....	1909	44.1	1.3	12.36	35.6	.....	4.3	2.07	Se=0.1, Co=0.2	4.781	19	175
5 Kretschmer.....	1911	44.8	1.4	12.4	34.0	0.24	6.6	0.6		4.780	21	175
6 Kretschmer.....	1911	44.6	2.0	11.9	34.37	.....	6.1	0.9		4.736	22	175
7 Kretschmer.....	1911	45.07	1.7	11.85	34.6	0.36	5.36	1.08		4.794	23	175
8 Hidegh.....	1880	44.75	2.2	11.4	33.7	0.7	6.3	0.95		4.910	32	178
9 Loczka.....	1901	45.2	0.3	12.75	33.7	0.8	5.55	0.8	Pb=0.1, Mn=0.7	4.968	38	179
10 Prior.....	1899	44.1	.....	14.1	29.34	8.64	.....	3.8		5.047	39	179
11 Ungemach.....	1906	45.0	0.9	12.0	30.75	3.15	4.25	3.9			42	179
12 Kretschmer.....	1911	45.1	2.1	11.56	30.86	0.8	5.7	0.8	Pb=0.8, Mn=0.3	4.870	43	179
13 Clarke-Owens.....	1880	44.7	.....	13.6	34.8	1.1	.....	0.67	Pb=5.17	4.350	4	183
14 Manasse.....	1906	45.0	.....	13.76	32.94	.....	1.48	6.6	Ni=0.2	.....	4	184
15 Manasse.....	1906	44.93	.....	13.9	33.3	.....	1.7	6.06	Ni=0.14	.....	5	184
16 Hidegh.....	1880	42.27	13.3	0.04	44.0	0.03	.....	0.37		4.926	6	185
17 Kretschmer.....	1911	42.64	12.56	.....	43.15	.....	0.2	1.46		4.746	7	185
18 Kretschmer.....	1911	43.7	12.96	1.05	39.54	0.1	.....	2.57		4.692	9	186
19 Prior.....	1899	44.4	13.2	.....	40.46	0.9	.....	1.0	Pb=0.08	4.620	4	187
20 Prior.....	1910	45.1	13.6	.....	34.1	0.6	6.1	0.6		4.610	8	187
21 Hidegh.....	1880	44.7	8.7	5.1	33.8	0.2	4.6	1.7	Mn=1.2	4.610	18	189
22 Genth.....	1885	45.3	2.4	11.9	33.16	0.3	6.1	0.64	Mn=0.1	4.885	20	190
23 Kretschmer.....	1911	44.7	6.54	7.06	34.9	0.1	4.0	2.5	Hg=0.2	4.738	22	190
24 Kretschmer.....	1911	44.6	7.4	6.54	36.1	0.04	1.2	4.17		4.740	23	190
25 Kretschmer.....	1911	44.85	8.9	4.8	35.1	0.02	4.95	1.4		4.597	24	190
26 De Benneville.....	1891	44.9	9.65	3.15	31.94	3.25	4.7	2.0	Mn=0.43	4.776	6	191
27 Steiger.....	1910	44.6	4.1	9.9	33.2	0.77	6.47	0.95		.....	7	191
28 Kretschmer.....	1911	44.6	11.5	2.0	34.2	0.6	2.1	5.0		4.576	8	191
29 Pilipenko.....	1915	44.9	4.16	9.5	31.5	3.2	2.8	3.9		4.800	10	191
30 Petersen.....	1881	44.07	14.16	8.15	37.77	.....	0.68	2.78	Bi=0.24, Co=0.26	4.870	7	192
31 Ungemach.....	1906	44.6	5.0	13.8	33.6	.....	4.3	3.7	Pb=0.1	4.82	9	192
32 Ungemach.....	1906	44.47	.....	13.7	34.4	0.06	5.8	1.1	Pb=0.2, Bi=0.14	5.10	10	192
33 Zsivny.....	1915	45.2	.....	.....	33.25	0.37	2.6	4.8	Pb=0.08	4.897	..	..

No. 33 is from *Ann. Hist. Nat. Mus. Hungar.*, XIII, 577, (1915); *Mineral. Abst.*, I, 336, (1921).

only two ways, one of which may lead to a complete and continuous series, while the other can only lead to a partial series. The first way is by a "replacement" of certain of its atoms by others of similar size, and the second is by acquiring *small* atoms which are not essential to the stability of the structure as a whole, but can find place in it *between* (and not "replacing") the larger essential atoms. The first case is illustrated by the complete series: $\text{NaAlSi}_2\text{Si}_2\text{O}_8 - \text{CaAlAlSi}_2\text{O}_8$, $\text{MgCO}_3 - \text{FeCO}_3$, Fe_2SiO_4 , etc. The second case is illustrated by the partial series: $\text{FeS}(+\text{S})$, $\text{Fe}_3\text{O}_4(+\text{O})$, $-\text{Mn}_2\text{SiO}_4$, $\text{NaAlSiO}_4(+\text{SiO}_2)$ etc. All of these cases are known to exist and it is demonstrated in each case of the second kind that the first term is essential and the second term is not essential to the existence of the space lattice, but that a limited amount of the second term can be added to the lattice without destroying or materially changing it.

It seems possible that the tetrahedrite-tennantite system is an example of a condition which may be considered to be intermediate between the two cases just described, or to illustrate both cases simultaneously. That is to say if $\text{Cu}_6\text{Sb}_2\text{S}_6$ be accepted as the fundamental molecule of tetrahedrite, then it is probable that in its space lattice Zn atoms may proxy for Cu atoms; these atoms are of similar size and a complete and continuous series might be expected to result. However, the Zn atoms belong to a molecule ($\text{Zn}_6\text{Sb}_2\text{S}_9$) which contains more S atoms than the fundamental tetrahedrite molecule so that one extra S atom is present for each pair of Zn atoms. The extra S atoms are small and not essential to the stability of the crystal space lattice, but they are essential to satisfy the valences of the Zn atoms. Accordingly, the number of Zn atoms which can proxy for Cu atoms in the tetrahedrite crystal space lattice is limited by the capacity of the lattice to accommodate extra S atoms.

Since tetrahedrite may therefore illustrate a new and complicated type of isomorphism it is important to study its constitution as fully as possible. X-ray patterns have been obtained from several tetrahedrite samples, but they are not very useful because they have not been made on analyzed material. The writer is eager to obtain samples of analyzed tetrahedrites in order to carry this part of the study further.

The analytical data of Table I may be used to test in various ways the two theories of the constitution of the tetrahedrite-

tennantite system. The most significant test which the writer has been able to develop is shown in the graph (Fig. 1); in which each numbered point represents the corresponding analysis of Table I, the point at the intersection of the two lines represents the position which all analyses should occupy if the theory of Wherry and Foshag is correct and if divalent Cu, assumed to be present in some cases, is added to Zn + Fe; further, the horizontal dashed

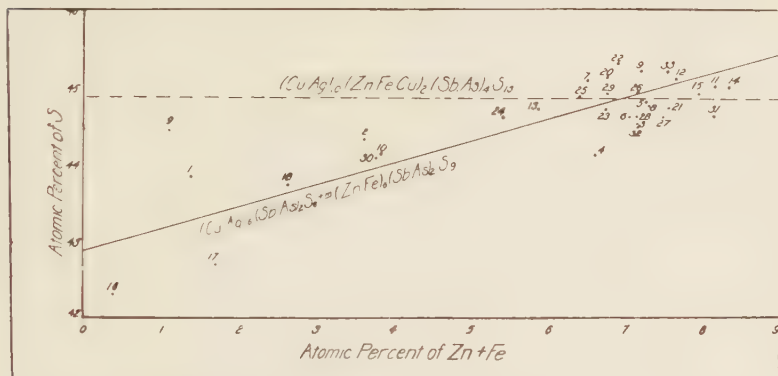


Fig. 1. Relation between Zn + Fe and S in the tetrahedrite-tennantite system.

line represents the position all analyses should take if the same theory is correct and divalent Cu is included with monovalent Cu; and the inclined line represents the position all analyses should take if the theory of Prior and Spencer is correct. A simple inspection of the diagram is sufficient to show that the best analytical data now available strongly support the theory of Prior and Spencer as opposed to that of Wherry and Foshag. However, no final decision in the matter is possible until sufficient analyses have been made on material of microscopically demonstrated purity.

CHLORITOID FROM THE DEEP RIVER REGION,
NORTH CAROLINAJASPER L. STUCKEY¹

INTRODUCTION

In 1923, while studying the pyrophyllite deposits in the Deep River region of North Carolina, the writer found, at the old Womble Mine, in Moore County, a dark green mineral in such abundance as to readily attract attention. Specimens collected and examined proved to be chloritoid. The pyrophyllite deposits have been described by both Emmons² and Pratt³ but neither mentioned the chloritoid. Genth⁴ mentioned chloritoid associated with pyrophyllite schist from Chatham County, North Carolina, but gave no details. The recent study indicates that the occurrence at the Womble Mine is different from that ordinarily described for chloritoid.

GEOLOGIC OCCURRENCE

The deposits lie along the eastern edge of the "Carolina Slate Belt" which is made up of volcanic rocks of pre-Cambrian age. In the Deep River region the rocks consist of slate, tuff, breccia, and flows of rhyolite and dacite; and tuff, breccia, and flows of andesite, all highly metamorphosed. Some of the coarse acid breccia contains considerable iron in the form of grains of hematite and magnetite and has been called "iron breccia."

Over an area some 20 miles long by 5 miles wide deposits of pyrophyllite are found in lenses from 500 to 2000 feet in length and 200 to 500 feet wide. The pyrophyllite bodies are always found associated with the tuff, breccia, and flows of rhyolite and dacite. The only variation from this is at the Womble Mine where the foot wall of the mineral body is a well developed iron breccia.

Chloritoid occurs in small amounts in practically every pyrophyllite body in the district, but it is found in important amounts only in the Womble Mine on the foot wall side near the iron

¹State Geologist, Department of Conservation and Development, Raleigh, N. C.

²Emmons, E.; Geological Report of the Midland Counties of North Carolina, Raleigh, (1856).

³Pratt, J. H.; Talc and Pyrophyllite in North Carolina, *N. C. Geol. Surv. Econ. Paper* 3 (1900).

⁴Genth, F. A.; Contributions from the Mineralogical Laboratory, University of Pennsylvania. *Amer. Phil. Soc.*, 13, 399, (1873).

breccia. This old mine was the first pyrophyllite mine opened in the United States and has been worked at intervals since 1856. During that time a large number of pits and shafts have been sunk on the mineral body. A large amount of chloritoid was found on the dumps on the foot wall side.

DESCRIPTION OF THE CHLORITOID

The typical chloritoid rock is a schist which varies from gray to greenish gray in color. The chloritoid is scattered through the rock in tiny crystals that vary from light to dark green in color and have a pearly luster.

In thin sections, the mineral varies from brown to dark green in color, the latter being much more abundant. The individual crystals are tabular and vary in size from 1 mm. in diameter to 0.3 mm. thick. It usually occurs, however, as sheaf-like patches made up of bladed crystals which are often twinned and without well defined crystal ends. The chloritoid often constitutes 30 percent of the rock. In some of the more schistose specimens it was observed altering to chlorite⁵.

The chief minerals associated with the chloritoid are quartz, pyrophyllite, chlorite, iron oxides (hematite and magnetite) and occasionally small particles of epidote.

For chemical analyses a specimen containing approximately 30 percent of chloritoid was selected. The rock was powdered and screened through a 70-mesh silk screen. The chloritoid was separated from the other minerals by Thoulet solution. Microscopic examination showed that the mineral used for analyses did not contain over 1 percent of impurities. This consisted of bits of quartz and pyrophyllite adhering to the chloritoid. The concentrated mineral had a specific gravity of 3.45 and analyzed as follows⁶:

SiO ₂	29.28
Al ₂ O ₃	37.98
Fe ₂ O ₃	2.32
FeO	21.97
MgO	1.28
CaO	Trace
H ₂ O	6.04
TiO ₂	0.86
MnO	0.29
Total	100.02

⁵Whittle, C. L.; *Amer. Jour. Sci.*, Ser. 3, 44, 270, (1892).

⁶Stuckey, J. L. Analyst.

The optical properties are as follows:⁷ Biaxial (+), elongation (-), inclined extinction 12° or more with marked dispersion of the bisectrices. The refractive indices all lie between 1.723 and 1.732. $\beta = 1.728 \pm .005$. Birefringence = .007.

Z makes an angle of about 15° with the normal to the base. No cleavage or crystal faces are present from which the positions of X and Y can be determined.

Z is colorless in thinner fragments and light yellow in somewhat thicker ones. Y is bluish green and X is yellowish green. Pleochroism is strongest in sections at steep angles with the basal cleavage.

ORIGIN OF THE CHLORITOID

Chloritoid is generally considered as characteristic of sedimentary rocks which have suffered the earlier stages of dynamic metamorphism, such as argillites. The occurrence described here is interesting because the chloritoid was not found in the region except in close association with the pyrophyllite and was best developed in the Womble Mine on the foot wall side in close association with the iron breccia.

The pyrophyllite has been formed by replacement under conditions of intermediate temperature and pressure by hot solutions coming up from below⁸. The pyrophyllite and chloritoid are closely associated. In most thin sections from the foot wall of the Womble Mine both pyrophyllite and chloritoid were present, replacing quartz. In a few sections chloritoid was found without pyrophyllite in which case it was replacing the silicified rock.

The marked concentration of the chloritoid in the Womble Mine near the iron breccia wall would seem to indicate that its formation was in some way influenced by that rock, while its close association with the pyrophyllite and its replacement of quartz would seem to indicate that it was formed by the same agencies and under approximately the same conditions as the pyrophyllite.

⁷The writer is greatly indebted to Mr. J. H. C. Martens of Cornell University for carefully checking all the optical properties of the mineral and determining the optical orientation, refractive indices and pleochroism.

⁸Stuckey, J. L. The Pyrophyllite Deposits of the Deep River Region of North Carolina. *Econ. Geol.* **20**, 442-463, (1925).

NITER AND SODA NITER
FROM BREWSTER COUNTY, TEXAS*

JOHN T. LONSDALE, *University of Texas*

Recently the occurrence of niter and soda niter in Brewster County, Texas, has been called to the attention of the Bureau of Economic Geology. The writer together with Dr. E. H. Sellards made a hasty examination of the nitrate deposit in August, 1925. It is thought that a brief note recording the occurrence is warranted.

The locality is the west side of Agua Fria Mountain on the Worthen Ranch, 55 miles south of Marathon and 10 miles west of the Marathon-Terlingua road. The name Agua Fria refers to a large spring of fresh water which issues from the base of the mountain and which is known throughout the region. The nitrate minerals are found a few yards distant from the spring, along the base of the mountain.

Agua Fria Mountain is composed essentially of a large mass of trachytic igneous rock, intrusive into sedimentary rocks of Cretaceous age. The west flank of the mountain is terminated by a sheer cliff several hundred feet high and approximately 400 feet in width at the base. The flanks of the cliff are masked by talus heaps but in the center of the cliff a great surface of igneous rock is exposed.

The cliff of igneous rock contains numerous vertical joints spaced about four feet apart. These range from mere threads to open cracks several inches in width. The nitrate minerals are found filling the joints as vein material. The veins are not continuous but consist of occasional masses and crusts varying from a fraction of an inch in thickness to slightly more than one inch. The length of individual vein fillings seen did not exceed two feet. Near the veins of nitrate minerals in some instances the rock is highly kaolinized. In some cases, also, the rock has been silicified for a distance of four inches from the vein or joint.

The vein material in some cases is snow white in color but in the majority of cases is stained brownish or grayish. It is possible to secure apparently pure specimens but these are limited to small samples. Blowpipe tests made on the material indicate nitrate minerals and the characteristic cooling taste is also noticed. An incomplete analysis, of a sample of the vein material, made in

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the Industrial Chemistry Experiment Station, University of Texas, is given below.

KNO ₃	36.29
NaNO ₃	36.35
NaCl	trace
CaCl ₂	trace
Na ₂ SO ₄	trace
CaSO ₄	trace

An undetermined insoluble residue was left.

The material is seen to be a mixture of sodium and potassium nitrates. This is verified by microscopic study which shows two minerals, one orthorhombic and the other rhombohedral. Due to the difficulty of manipulating these highly soluble materials and the lack of a liquid sufficiently low in refractive index the optical constants were not completely determined.

The soda niter exhibited perfect rhombohedral cleavage, was optically negative and showed $\omega = 1.585 \pm .005$. The niter was negative, showed $\gamma = 1.500 \pm .005$ and was typically orthorhombic. Birefringence in both cases was extremely high. The values for ϵ and α , respectively, were not determined but the extremely high birefringence indicates values close to those quoted in Larsen's tables. It is believed that the data available are sufficient to establish the minerals as niter and soda niter.

The origin of these nitrates is not plain and no attempt is made here to explain their occurrence. The igneous rocks in which the nitrate veins are found were once covered by sedimentary rocks in which cave deposits might have occurred. At the present time there is no evidence of guano or similar deposits. There is some indication that hot solutions have travelled along the joints and crevices in the igneous rock but the relation of such solutions to the nitrates is not known. Somewhat similar deposits have been reported from Presidio County, Texas, and it is hoped that these along with the deposits of Agua Fria may be described in greater detail in a later paper.

BOOK REVIEWS

UEBER DIE SYSTEMATIK DER ERZLAGERSTÄTTEN. W. A. OBRUTSCHEW, *Abhandlungen zur praktischen Geologie und Bergwirtschaftslehre*, Vol. 4. Berlin, 21 pages (1926). Published by WILHELM KNAPP, HALLE (SAALE).

The question of classification is in every science almost as old as the science itself. As our knowledge increases new problems are encountered and the old schemes are no longer sufficient. The classification of ore deposits has always

been, more or less, a matter of personal judgment; the first ones were purely morphological, whereas the later classifications have a tendency to be based upon genetic principles.

The author discusses the important classifications which have been published in the past fifteen years; such as the Beyschlag-Krusch-Vogt, de Launay, Lindgren, Emmons, and others. Less important classifications are mentioned briefly if they have some bearing upon the better known schemes. All these classifications are discussed in a critical way. For example, several classifications do not present a scientific foundation upon which they are based, as they have been formed partly along morphological and partly along genetic lines. Others, as the ones of Lindgren and Niggli, are too elaborate for practical purposes and difficult to keep in mind; particularly the classification of Niggli which is more a working principle for genetic mineralogy than a practical classification of ore deposits.

It is the author's intention to indicate a new scheme, one based entirely upon the genesis of the deposits, thereby assuming that the formation of an ore deposit is merely a special form of general geological and mineralogical processes. A detailed discussion is presented for every one of the proposed classes, after which the new classification is proposed in the form of a table. Three main subdivisions, five general classes, and nineteen subclasses are given. The subdivisions, and general classes are as follows:

A. ENDOGENIC DEPOSITS:

- I. Magmatic or magmatogenic deposits.
- II. Deposits formed by exhalations, or ematogenic deposits.
- III. Hydrothermal deposits.

B. EXOGENIC DEPOSITS:

- IV. Sedimentary deposits.
- V. Deposits formed by weathering, or dialytic deposits.

C. METAMORPHOGENIC DEPOSITS:

In the opinion of the author, any deposit may be placed somewhere in this classification, although he admits that the place of the "intermediate" forms (Uebergangsglieder) will be in most cases a matter of personal opinion and judgment.

Tj. L. REITSEMA

DER NORDALBANISCHE ERZBEZIRK. ERNST NOWACK. *Abhandlungen zur praktischen Geologie und Bergwirtschaftslehre*, Vol. 5. Berlin, 1926, 32p. with 5 plates. Published by WILHELM KNAPP, HALLE (SAALE).

The article is a report on the possibilities for the commercial exploitation of ore deposits in northern Albania. The author has been in charge of a geological reconnaissance of this region for the Albanian Government, and investigations of the deposits in question have not yet reached beyond the stage of scattered observations.

Historically little is known about the mining possibilities of northern Albania. The development of the interior is greatly retarded by the absence of good roads; only a few caravan trails are present and travelling is exceedingly difficult.

At present, only the pyrite deposits around Kalivari (about 50 km. east of Scutari), and perhaps the sulphide copper deposits of Kabash, to the north, are of some commercial importance. Other deposits are too isolated, and practically nothing is known about their real magnitude.

The geology of the region is very complex, one of the principal features is the presence of two series of igneous rocks, one Triassic, forming principally sills and sheets, and one Jurassic, being composed of a great series of bosses and stocks.

As for the genesis of the ore deposits, the large pyrite mass, is generally considered of epigenetic origin. In the extreme northeast, near Kruma, syngenetic chromite is found, but this occurrence is not yet of economic importance. Other types of occurrences are veins and metasomatic iron ores in limestone or shale.

It is the author's opinion that the origin of the large pyritiferous deposits is connected with the Tertiary igneous intrusions. Outcrops of these igneous masses have not been found in the region, but are present in southern Albania and in Greece. Fourteen references are given at the end of the first chapter.

TJ. L. REITSEMA

VERSUCH EINER NATÜRLICHEN KLASSIFIKATION DER IM WEITEREN SINNE MAGMATISCHEN ERZLAGERSTÄTTEN. PAUL NIGGLI. 69 pages, 11 figs. *Abhandlungen zur praktischen Geologie und Bergwirtschaftslehre*, Vol. 1. Berlin, 1925. Published by WILHELM KNAPP, HALLE (SAALE).

The author first considers the general principles of physical chemistry of the magmas forming ore deposits. A curve showing the effect of temperature and pressure on a magmatic system is given. A discussion of the succession of paragenesis of elements and the minerals containing them is presented with a diagram summarizing the information.

The well known associations of metals with certain types of igneous rocks is considered in some detail. The paper should prove of interest to the general reader.

W. H. NEWHOUSE

PROCEEDINGS OF SOCIETIES

PHILADELPHIA MINERALOGICAL SOCIETY

Academy of Natural Sciences of Philadelphia, May 6, 1926.

A stated meeting of the Philadelphia Mineralogical Society was held on the above date, with the president, Mr. Vaux, in the chair. Twenty-nine members and three visitors were present.

Messrs. Biernbaum and Hoadley exhibited datolite and an unidentified crystalline mineral from Patterson, N. J., and reported that there were excellent prospects that these quarries would produce very good specimens in the near future.

Mr. Hoadley reported garnet, apatite, and beryl from the New York City subway excavations. Mr. Warford reported finding apatite crystals in a quarry near Dutton's Mills, Pa., on a trip with several other members of the society. A specimen of crystallized pyrite on stilbite from Moore Station, N. J., was exhibited by Mr. Trudell. Messrs. Vaux and Gordon exhibited a large calcite crystal, and a large specimen of apophyllite colored green by included byssolite. Both were obtained recently at the French Creek Mines, Pa.

The meeting then adjourned to the microscope room of the Academy, where Dr. L. C. Wills, assisted by several other members, had arranged a splendid exhibition of microscopic minerals. Twenty-one microscopes and a large and varied array of specimens assured a most interesting evening for all present.

HORACE R. BLANK, *Secretary*

NOTES AND NEWS

The following have indicated their desire to exchange mineral specimens with other members of the Society: Dr. Henry C. Dake, 793½ Thurman St., Portland, Oregon; Lloyd W. Fischer, Dept. of Mineralogy, Brown University, Providence, Rhode Island; Walter J. Paquette, 253 Worthington St., Toledo, Ohio; and M. Vonsen, Petaluma, California.

Professor W. J. Lewis, professor of mineralogy at the University of Cambridge, died on April 16 at the age of seventy-nine years. In 1899 Professor Lewis published a treatise on crystallography and in 1909 he was elected Fellow of the Royal Society.

Prof. L. A. Wülfing, professor of mineralogy and petrography at the University of Heidelberg, and Prof. O. Mügge, professor of mineralogy at the University of Göttingen, will retire from active service at the close of the present college year.

The Academy of Sciences of Paris has awarded the Cuvier prize in mineralogy and geology to Dr. L. Kober of the University of Vienna.

Prof. H. Mohr of the T. H. at Graz has received a call to the professorship of mineralogy and geology at the University of Brunn.

Mr. John C. Smock, for many years connected with the New Jersey geological survey, died April 21 at the age of eighty-four years. Mr. Smock graduated from Rutgers college and later received his Ph.D. from Lafayette. The year 1869-1870 was spent at the Bergakademie and the University of Berlin. His contributions were mainly in the field of economic geology and included studies on clay deposits and reports on building stones and iron ores of New York.

Mr. Ernest E. Fairbanks, mineralogist at the Rare and Precious Metals Experiment Station, Reno, Nevada, has resigned to accept a position on the sales staff of E. Leitz, Inc., of New York City.

Volume one of the International Critical Tables of the numerical data of physics, chemistry and technology is now off the press. These tables were published under the direction of the National Academy of Sciences and the National Research Council. The material has been assembled and evaluated by three hundred experts including chemists, physicists and engineers of the United States, Canada, Great Britain, Belgium, France, Italy, Austria, Germany, Denmark, Switzerland, Holland, Australia and Japan. The special prepublication offer, which closed May 1, brought in subscriptions for 6,500 sets. Of these twenty percent were from foreign countries.

Joint investigations by the Bureau of Soils of the United States Department of Agriculture and the United States Geological Survey to determine the location and extent of potash deposits in the United States and to develop improved methods of recovery are provided for in a bill which has been reported out with amendments by the Senate Committee on Agriculture.

According to Dr. George Kunz the "new" gem mineral recently reported from Santa Rita, Minas Geraes, Brazil, is an azure blue lazulite.

Dr. Horace R. Blank, instructor in chemistry at the University of Pennsylvania and secretary of the Philadelphia Mineralogical Society, has been appointed instructor in mineralogy at Columbia University, New York City.

NEW MINERAL NAMES

Bolivianite

ANTONIO PAULY: Bolivianite und Silesite zwei neue Mineralien der bolivianischen Zinnlagerstätten. (Bolivianite and silesite, two new minerals from the Bolivian tin deposits). *Centr. Min. Geol.*, 43-44 (1926).

NAME: This mineral is called *bolivianite* by the miners.

CHEMICAL COMPOSITION: A tin-copper sulphide. Analysis: Sn 35, Cu 25, S 33, with iron sometimes up to 10 percent. Some samples also show Ge and Ag. Fusible at 4.

CRYSTALLOGRAPHIC PROPERTIES: Trigonal. c = about 0.8 Form, rhombohedrons.

PHYSICAL PROPERTIES: Color black with bluish tarnish, streak brownish yellow. Cleavage, rhombohedral, good. Hd 4-5. Sp. Gr. 4.1.

OCCURRENCE: Found in druses in the tin ores of Quimsa Cruz and Huanuni.

DISCUSSION: (A specimen of bolivianite in the collection of the U. S. National Museum agrees with Pauly's description but is sphalerite partially replaced by covellite. The term bolivianite has already been used for an antimonial silver sulphide. Abstr.)

W. F. FOSHAG

Cannizzarite

F. ZAMBONINI, O. DE FIORE and G. CAROBBI: *Rend. Accad. Sci. Fis. Mat. Napoli*, (3) 31, 24-29 (1925). Also *Annali del R. Osservatorio Vesuviano*, (3) 1, 31-36 (1924).

CHEMICAL PROPERTIES: A bismuth sulphosalt of lead, $PbS.Bi_2S_3$. Analysis: Bi 66.00, Pb 15.79, FeO 0.51 Cu tr., S 17.70 (by difference).

CRYSTALLOGRAPHIC PROPERTIES: Probably orthorhombic. Crystals are striated prisms with the forms b (010), m (110), a (100), n (210), q (130). (010) : (110) = $44^\circ 47'$ to $46^\circ 40'$.

PHYSICAL AND OPTICAL PROPERTIES: Color lead gray. Sp. Gr. 6.54. Hd. 2.

OCCURRENCE: Found in the deeper parts of fumaroles (Temp. 550-615°C) as flattened acicular crystals on Vulcano, Lipari Islands. The higher levels of the fumaroles carry sal ammoniac, realgar and sulphur.

DISCUSSION: (Very close to chiviatite and is probably identical with it. Abstr.)

W. F. F.